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Asano et al.

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(54) **IMAGE PROCESSING APPARATUS AND METHOD FOR GENERATING AN IMAGE SIGNAL FOR GRADATION**

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G06K 15/00 (2006.01)

(52) **U.S. Cl.** **358/3.06**; 358/1.9; 358/3.13; 382/266

(58) **Field of Classification Search** 358/3.13, 358/3.14, 3.15, 3.16, 3.17, 3.18, 3.19, 1.9, 358/3.06; 382/266, 269
See application file for complete search history.

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(57) **ABSTRACT**

An image processing apparatus includes a receiving section, an edge detection section and a screen processing section. The receiving section receives image information. The edge detection section detects an edge area from the image information received by the receiving section. The screen processing section performs a screen process, which is based on area coverage modulation, for the image information on a basis of the detection result by the edge detection section. The screen processing section performs a screen process for the edge area detected by the edge detection section with (i) a screen angle, which is equal to that of a screen process performed for a non-edge area other than the edge area, and (ii) a number of lines per inch, which is an integer multiple of that of the screen process performed for the non-edge area.

8 Claims, 8 Drawing Sheets

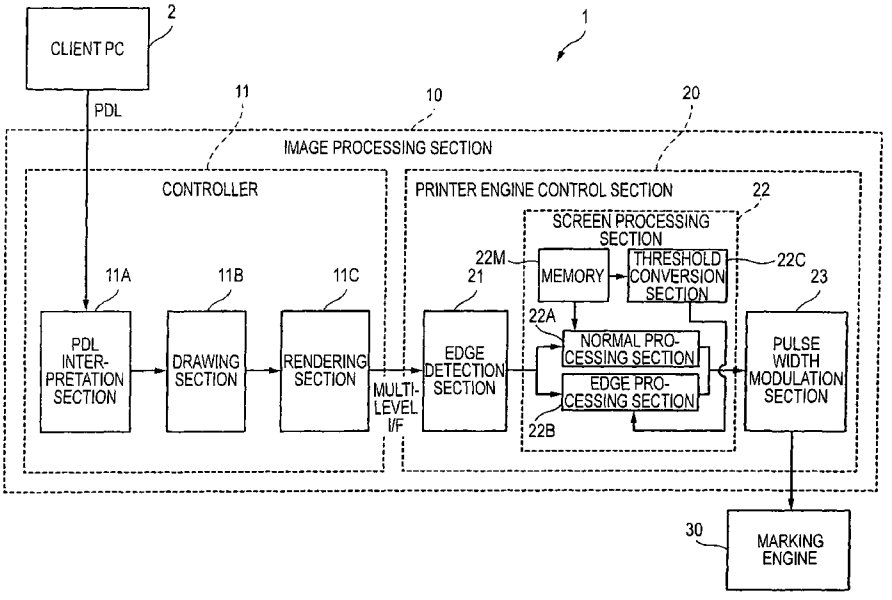


FIG. 1

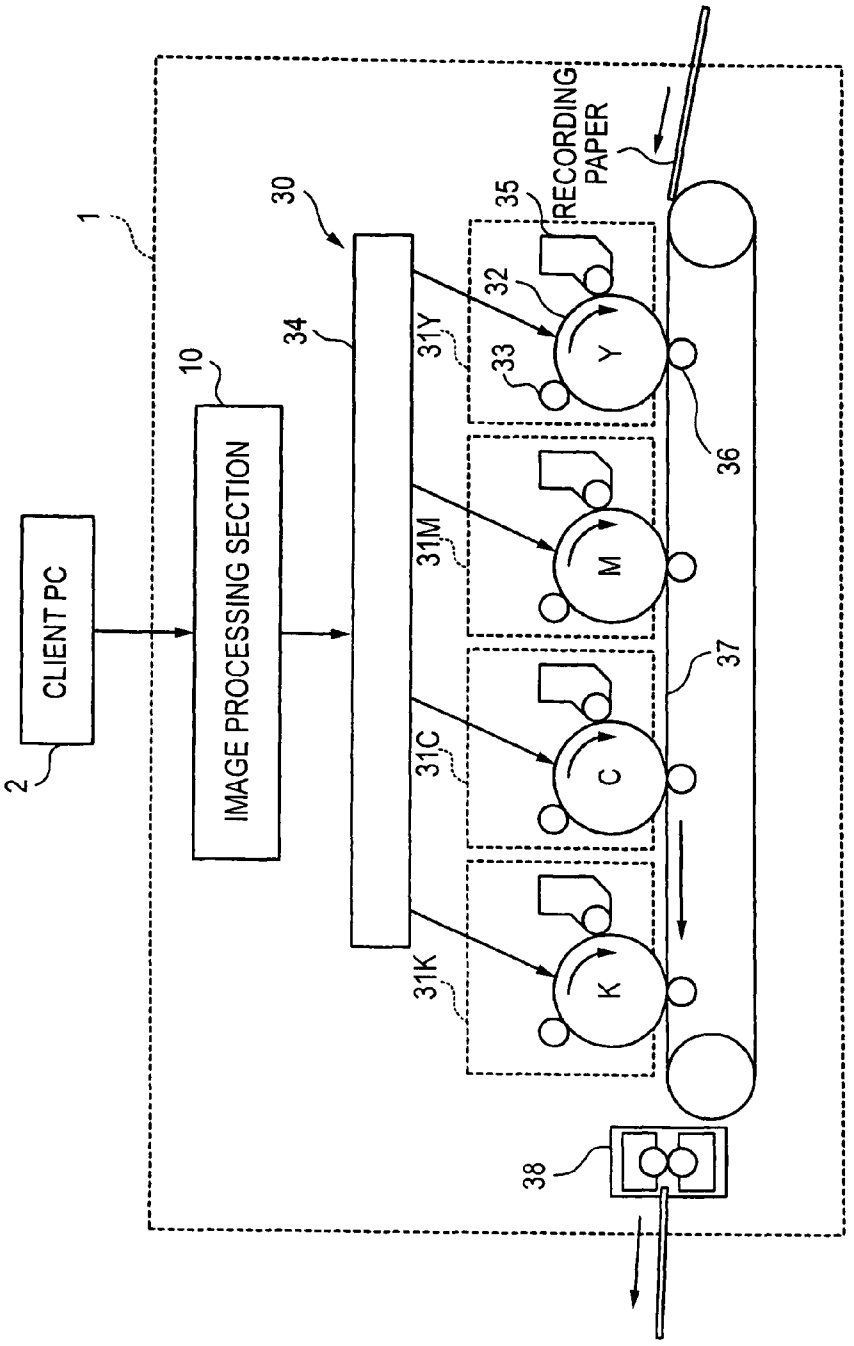

1
2
CLIENT PC
10
IMAGE PROCESSING SECTION
30
34
31Y
31M
31C
31K
32
33
35
RECORDING PAPER
36
37
38
Y
M
C
K

FIG. 2

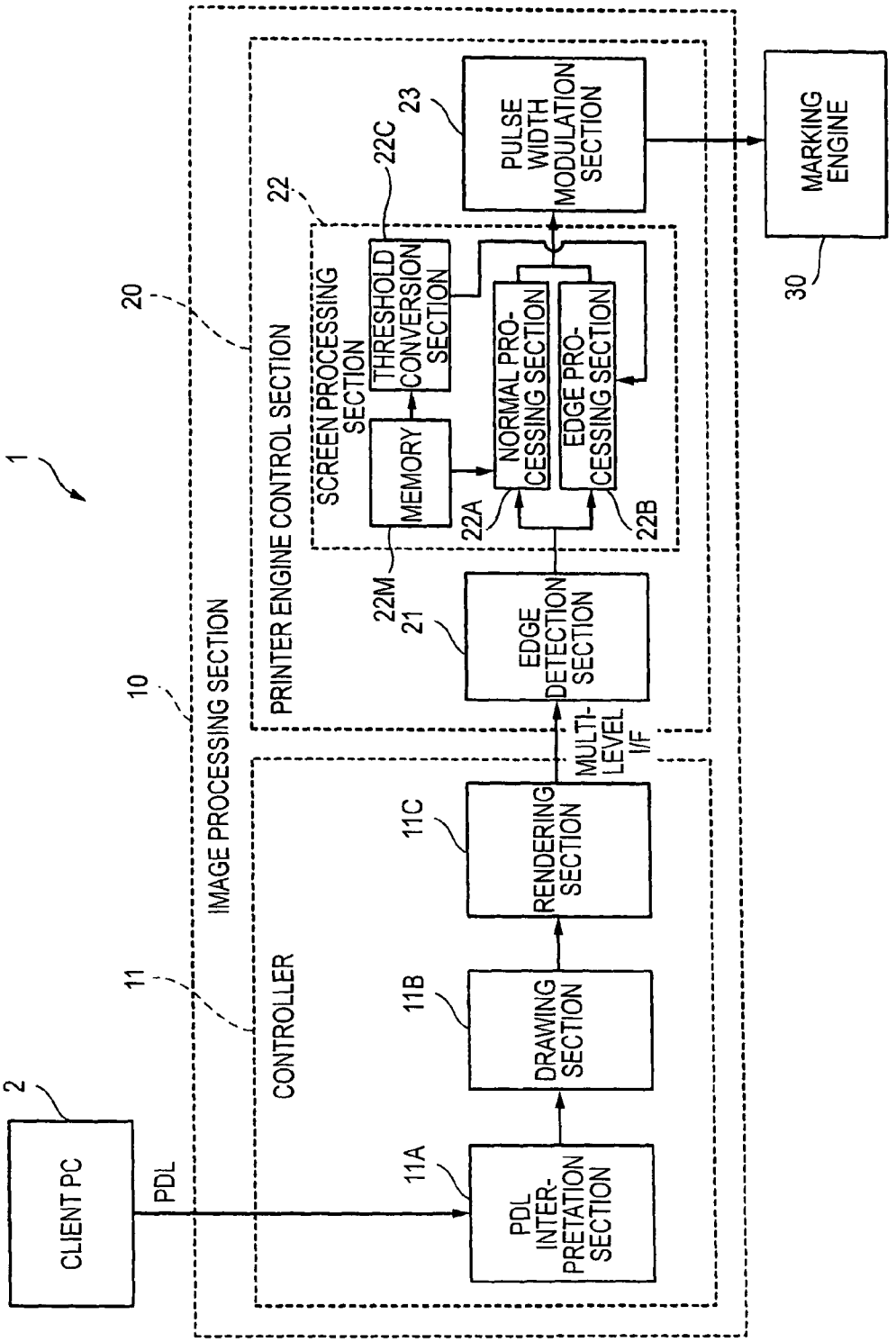
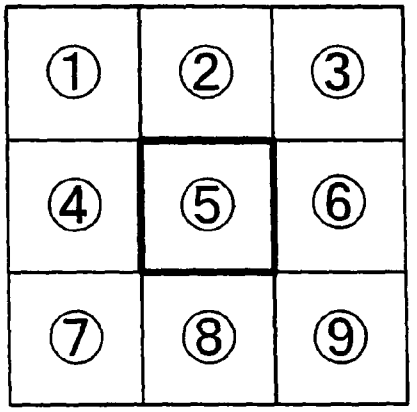

1
2
CLIENT PC
PDL
10
IMAGE PROCESSING SECTION
11
CONTROLLER
11A
PDL INTER-PRETATION SECTION
11B
DRAWING SECTION
11C
RENDERING SECTION
MULTI-LEVEL I/F
20
PRINTER ENGINE CONTROL SECTION
21
EDGE DETECTION SECTION
22M
22
SCREEN PROCESSING SECTION
MEMORY
22A
NORMAL PRO-CESSING SECTION
EDGE PRO-CESSING SECTION
22B
THRESHOLD CONVERSION SECTION
22C
23
PULSE WIDTH MODULATION SECTION
30
MARKING ENGINE

FIG. 3A



⑤: Pixel in question

FIG. 3B

<Density Difference Determination>

SH =| (①+②+③) - (⑦+⑧+⑨)|
SV =| (①+④+⑦) - (③+⑥+⑨)|
SR =| (①+②+④) - (⑥+⑧+⑨)|
SL =| (④+⑦+⑧) - (②+③+⑥)|

Max(SH,SV,SR,SL) ≧ Edge threshold value → Edge area
Max(SH,SV,SR,SL) < Edge threshold value → Non-edge area

FIG. 4A

211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226
210	157	158	159	160	161	162	163	164	165	166	167	168	169	170	227
209	156	111	112	113	114	115	116	117	118	119	120	121	122	171	228
208	155	110	73	74	75	76	77	78	79	80	81	82	123	172	229
207	154	109	72	43	44	45	46	47	48	49	50	83	124	173	230
206	153	108	71	42	21	22	23	24	25	26	51	84	125	174	231
205	152	107	70	41	20	7	8	9	10	27	52	85	126	175	232
204	151	106	69	40	19	6	1	2	11	28	53	86	127	176	233
203	150	105	68	39	18	5	4	3	12	29	54	87	128	177	234
202	149	104	67	38	17	16	15	14	13	30	55	88	129	178	235
201	148	103	66	37	36	35	34	33	32	31	56	89	130	179	236
200	147	102	65	64	63	62	61	60	59	58	57	90	131	180	237
199	146	101	100	99	98	97	96	95	94	93	92	91	132	181	238
198	145	144	143	142	141	140	139	138	137	136	135	134	133	182	239
197	196	195	194	193	192	191	190	189	188	187	186	185	184	183	240
256	255	254	253	252	251	250	249	248	247	246	245	244	243	242	241

FIG. 4B

211	213	215	217	219	221	223	225
209	111	113	115	117	119	121	171
207	109	43	45	47	49	83	173
205	107	41	7	9	27	85	175
203	105	39	5	3	29	87	177
201	103	37	35	33	31	89	179
199	101	99	97	95	93	91	181
197	195	193	191	189	187	185	183

FIG. 5A

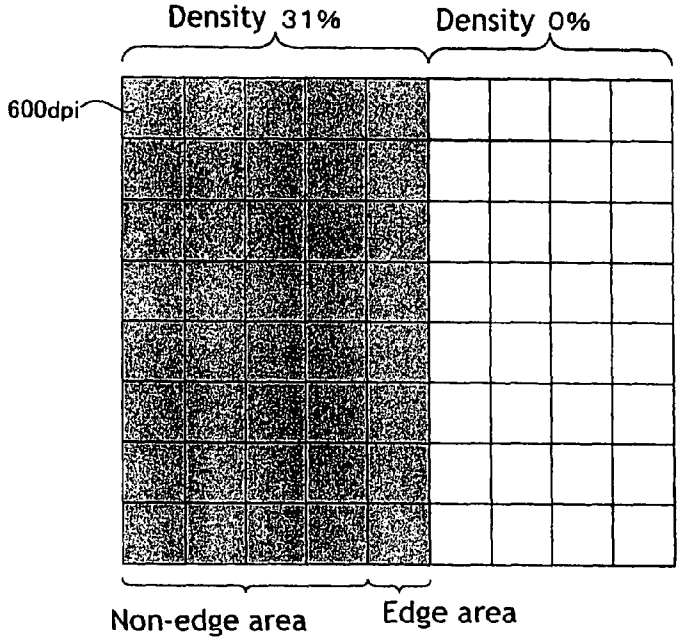


FIG. 5B

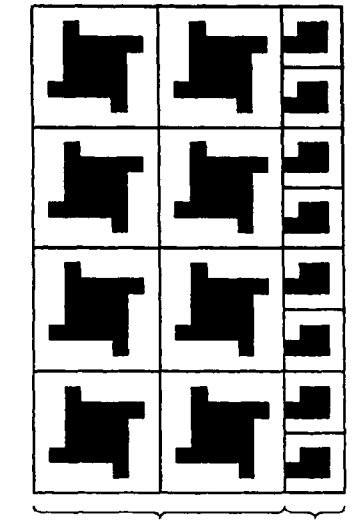


FIG. 5C

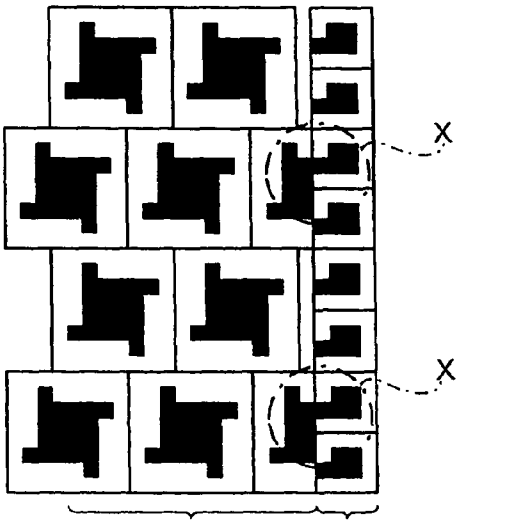


FIG. 6

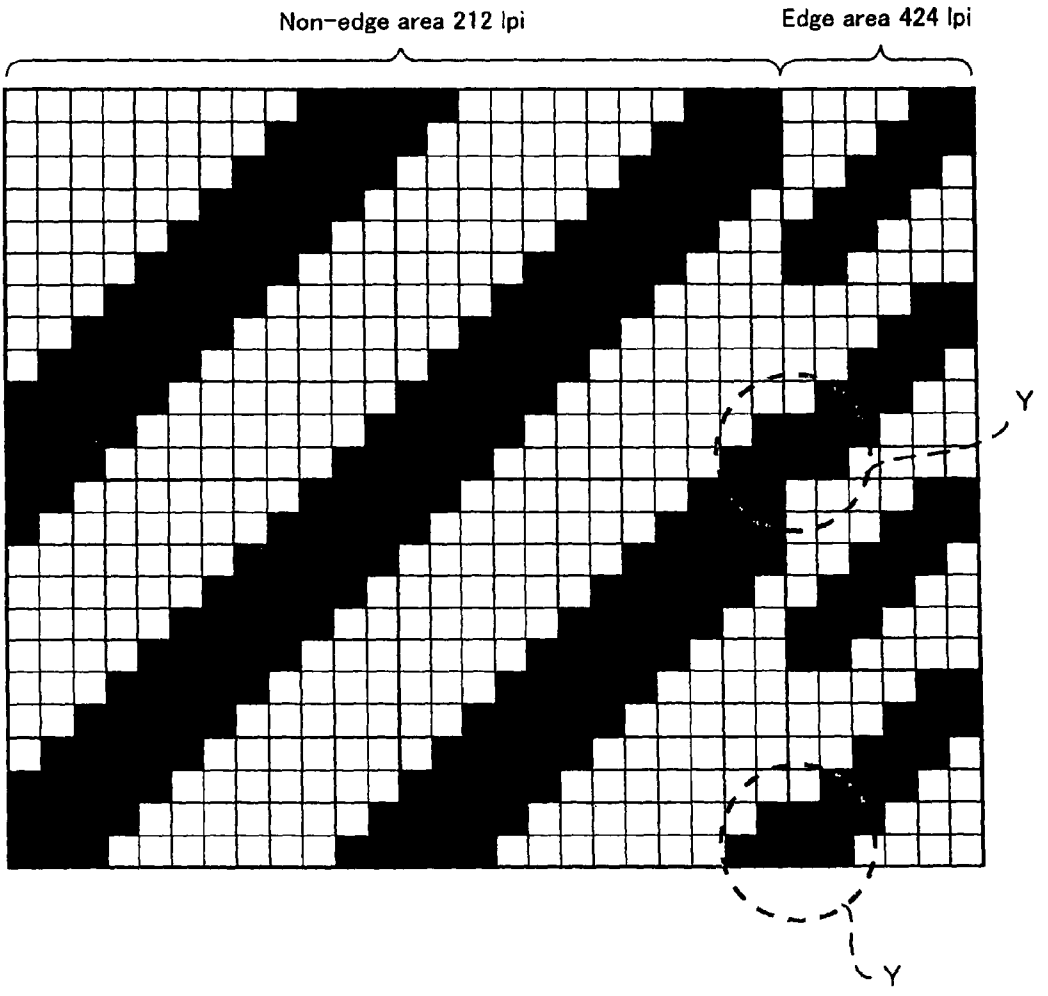


FIG. 7

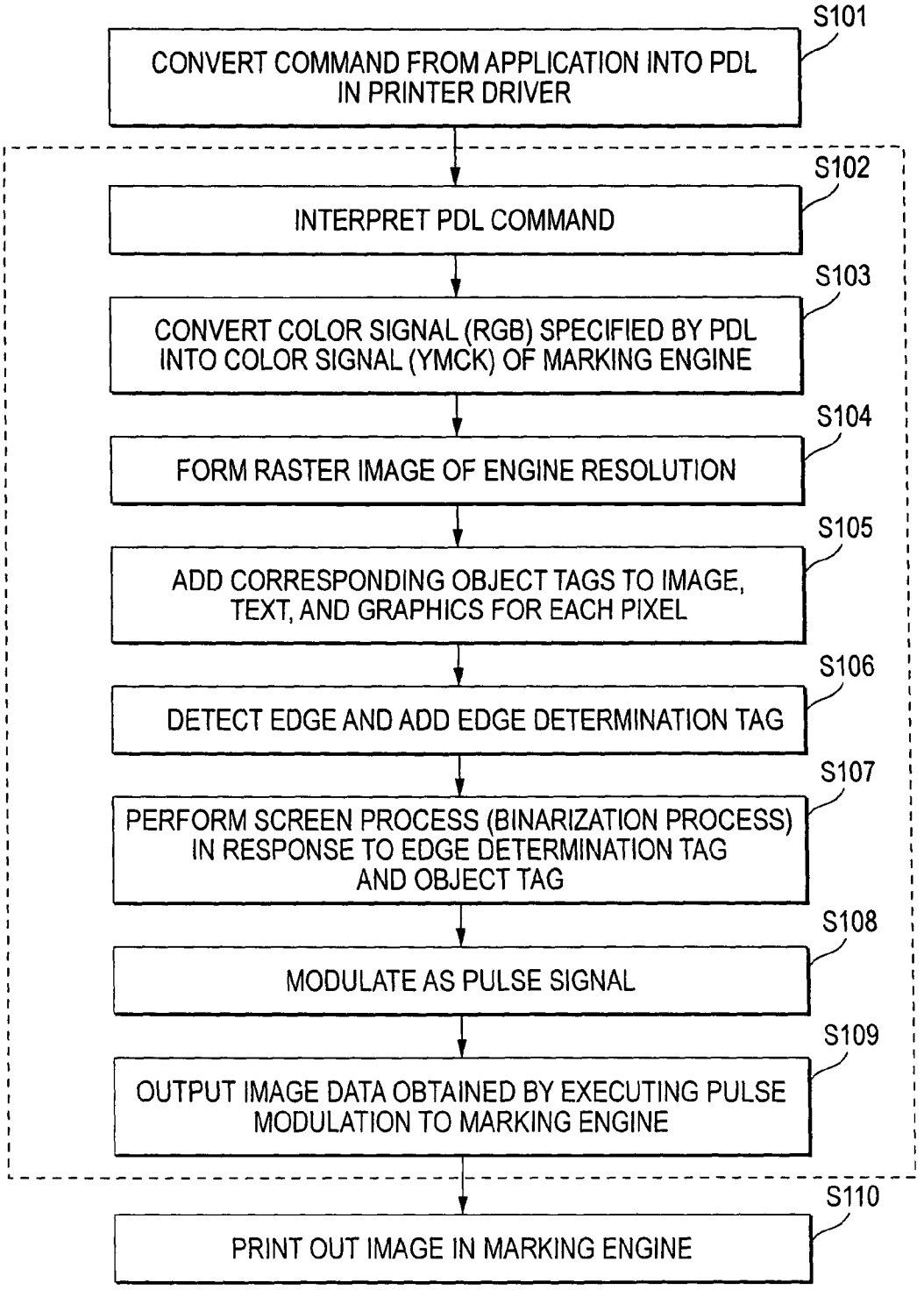

S101
CONVERT COMMAND FROM APPLICATION INTO PDL IN PRINTER DRIVER
S102
INTERPRET PDL COMMAND
S103
CONVERT COLOR SIGNAL (RGB) SPECIFIED BY PDL INTO COLOR SIGNAL (YMCK) OF MARKING ENGINE
S104
FORM RASTER IMAGE OF ENGINE RESOLUTION
S105
ADD CORRESPONDING OBJECT TAGS TO IMAGE, TEXT, AND GRAPHICS FOR EACH PIXEL
S106
DETECT EDGE AND ADD EDGE DETERMINATION TAG
S107
PERFORM SCREEN PROCESS (BINARIZATION PROCESS) IN RESPONSE TO EDGE DETERMINATION TAG AND OBJECT TAG
S108
MODULATE AS PULSE SIGNAL
S109
OUTPUT IMAGE DATA OBTAINED BY EXECUTING PULSE MODULATION TO MARKING ENGINE
S110
PRINT OUT IMAGE IN MARKING ENGINE

FIG. 8

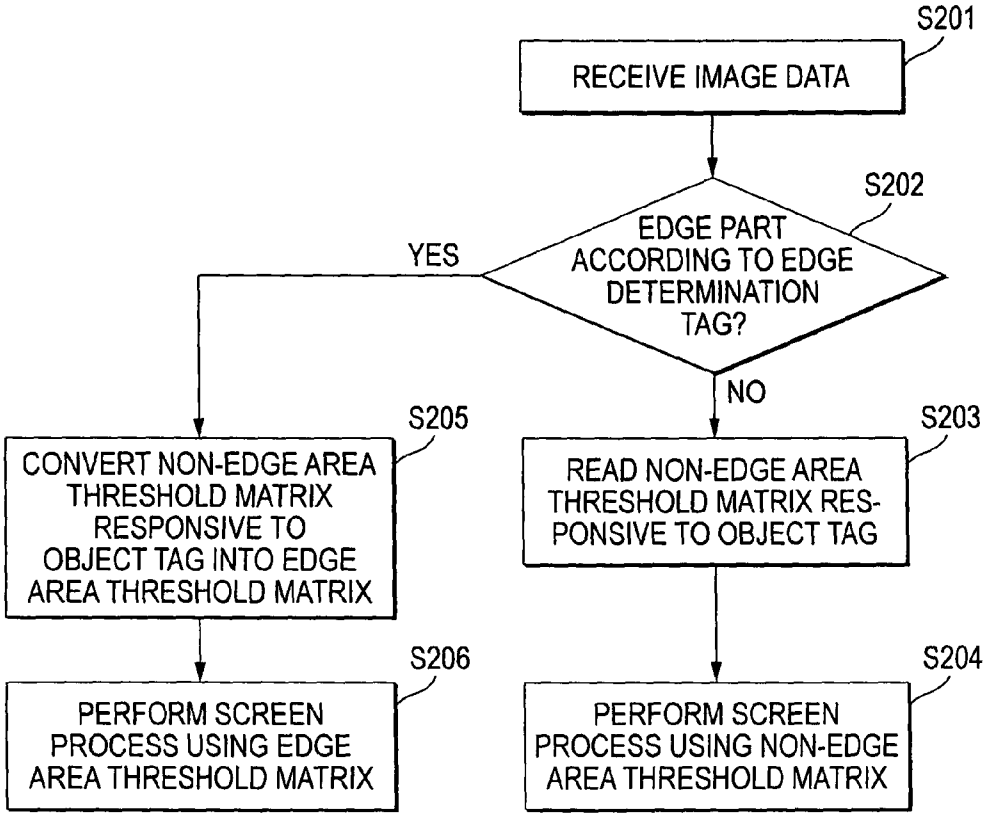

S201
RECEIVE IMAGE DATA
S202
EDGE PART ACCORDING TO EDGE DETERMINATION TAG?
YES
NO
S205
CONVERT NON-EDGE AREA THRESHOLD MATRIX RESPONSIVE TO OBJECT TAG INTO EDGE AREA THRESHOLD MATRIX
S203
READ NON-EDGE AREA THRESHOLD MATRIX RESPONSIVE TO OBJECT TAG
S206
PERFORM SCREEN PROCESS USING EDGE AREA THRESHOLD MATRIX
S204
PERFORM SCREEN PROCESS USING NON-EDGE AREA THRESHOLD MATRIX

IMAGE PROCESSING APPARATUS AND METHOD FOR GENERATING AN IMAGE SIGNAL FOR GRADATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 U.S.C. §119 from Japanese Patent Application No. 2006-329284 filed on Dec. 6, 2006.

BACKGROUND

1. Technical Field

The invention relates to an image processing apparatus and an image processing method for generating an image signal representing gradation using an area coverage modulation method.

2. Related Art

An image formation apparatus such as a copier or a printer using electrophotography, an ink jet system, etc., performs for input image information a screen process of artificially reproducing a halftone with binary values representing presence or absence of a drawing dot, and outputs the result by means of an output device.

A document generated by such an image formation apparatus includes various objects from the viewpoint of the image quality, such as an image of a photo, etc., graphics of gradation, patch, etc., and text, a line, etc.,

The number of lines per inch (how many identical patterns are contained per inch) is a representative parameter of the screen process. The optimum number of lines for the image object varies from one image object to another.

For example, preferably an image is generated with 200 lines per inch from the viewpoint of the human's eye characteristic. However, 170 to 230 lines per inch are often used because the gradation property and graininess are degraded due to the responsiveness of a marking engine if the number of lines per inch is high and because a screen structure is seen or texture is lost if the number of lines per inch is low.

For graphics, importance is further placed on the gradation property and graininess. Thus, 150 to 200 lines per inch are often used, and 300 lines or more per inch are often used for text and a line, which are desired to have no jaggy and no break.

That is, preferably the number of lines per inch is high as much as possible to smoothly represent text, a line, etc., but the gradation property and graininess are degraded if the number of lines per inch is too high.

Thus, the screen process is performed with a different number of lines per inch in response to each object. That is, plural threshold matrices different in the number of lines per line are stored and the screen process is performed with a different number of lines per inch in response to an object using the threshold matrices.

SUMMARY

According to an aspect of the invention, an image processing apparatus includes a receiving section, an edge detection section and a screen processing section. The receiving section receives image information. The edge detection section detects an edge area from the image information received by the receiving section. The screen processing section performs a screen process, which is based on area coverage modulation, for the image information on a basis of the detection result by the edge detection section. The screen processing section performs a screen process for the edge area detected by the edge detection section with (i) a screen angle, which is equal to that of a screen process performed for a non-edge area other than the edge area, and (ii) a number of lines per inch, which is an integer multiple of that of the screen process performed for the non-edge area.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will be described in detailed below with reference to the accompanying drawings, wherein:

FIG. **1** is a drawing to show the general configuration of a printer system according to an exemplary embodiment of the invention;

FIG. **2** is a block diagram to show the configuration of an image processing section;

FIG. **3** is a schematic representation of an example of edge detection by an edge detection section;

FIG. **4** is a drawing to show an example of a threshold matrix used in a screen processing section;

FIG. **5** is a drawing to describe the screen angle effect in a screen process;

FIG. **6** is a drawing to describe periodicity of a screen boundary portion;

FIG. **7** is a flowchart to show a flow of image processing; and

FIG. **8** is an operation flow of the screen processing section.

DETAILED DESCRIPTION

Referring now to the accompanying drawings, exemplary embodiments of the invention will be described.

FIG. **1** is a drawing to show the general configuration of a printer system according to an exemplary embodiment of the invention. Here, provided are an image formation apparatus **1** for expanding input information of an electronic document into an image and printing the image on a sheet of paper and a client PC (personal computer) **2** of a host computer for providing the electronic document for the image formation apparatus **1**. Image data may be input to the image formation apparatus **1** from an image reader (not shown) other than the client PC **2**.

The image formation apparatus **1** includes an image processing section **10** for performing predetermined image processing for the image data of the electronic document output from the client PC **2**, for example, and a marking engine **30** serving as an image formation section. For example, the image formation section may be a tandem digital color printer using electrophotography.

The marking engine **30** includes plural image formation units **31**Y, **31**M, **31**C, and **31**K (hereinafter referred to as image formation unit **31** unless otherwise described for each color) placed in parallel with a given spacing in the horizontal direction and an exposure unit **34** for exposing a photoconductor drum **32** of each image formation unit **31** to light. That is, the image formation apparatus **1** forms a color image.

The image formation units **31**Y, **31**M, **31**C, and **31**K form Y (yellow), M (magenta), C (cyan), and K (black) toner images and transfer the toner images in sequence onto a sheet of recording paper serving as a recording medium.

The exposure unit **34**, although not described in detail, is a multibeam exposure scan unit for collectively scanning plural laser beams emitted from a vertical cavity surface emission laser array chip having a light emission point group made up of plural light emission points and introducing the laser beams to the photoconductor drums **32** of the image forma-

tion units **31**. Accordingly, it is made possible to form an image with a resolution of 2,400 dpi, for example.

Each of the four image formation units **31** includes the photoconductor drum **32**, which is an image carrier (photoconductor), for forming an electrostatic latent image and holds a toner image, a charger **33** for uniformly charging the surface of the photoconductor drum **32**, and a developing device **35** for developing the electrostatic latent image formed by the exposure unit **34**. Each of the four image formation units **31** also includes a transfer roll **36** for transferring the toner image formed on the surface of the photoconductor drum **32** to a sheet of recording paper.

The marking engine **30** further includes a paper transport belt **37** for transporting the sheet of recording paper to a transfer position formed of the photoconductor drum **32** and the transfer roll **36** of each image formation unit **31**. The marking engine **30** also includes a fixing device **38** for fixing the toner image transferred onto the sheet of paper.

Only the image processing section **10** rather than the whole of the image formation apparatus **1** may also be considered as the image processing apparatus.

Each of the four image formation units **31** includes almost similar components other than the color of toner stored in the developing device **35**. The image data input from the client PC **2** is subjected to image processing by the image processing section **10** and is supplied to the marking engine **30** through a predetermined interface. The marking engine **30** operates based on a control signal of a synchronizing signal, etc., supplied from an image output control section (not shown). First, the yellow (Y) image formation unit **31**Y forms an electrostatic latent image by the exposure unit **34** based on an image signal obtained from the image processing section **10** on the surface of the photoconductor drum **32** charged by the charger **33**. The yellow (Y) image formation unit **31**Y forms a yellow (Y) toner image by the developing device **35** for the electrostatic latent image and transfers the formed yellow (Y) toner image to record paper on the paper transfer belt **37** rotating in the arrow direction in the figure using the transfer roll **36**. Likewise, M (magenta), C (cyan), and K (black) toner images are formed on the photoconductor drums **32** and are multiplely transferred to the record paper on the paper transfer belt **37** using the transfer rolls **36**. The multiplely transferred toner image on the record paper is transported to the fixing device **38** and is fixed on the paper using heat and pressure.

The marking engine **30** of the image formation apparatus **1** shown in FIG. **1** adopts the configuration wherein the toner images are transferred onto the transported record paper in order. However, an image formation apparatus of a secondary transfer system adopting an intermediate transfer belt instead of the paper transfer belt **37** for multiplely transferring toner images onto the intermediate transfer belt and then secondarily transferring the toner images onto record paper in batch can also be adopted.

Next, the image processing section **10** according to the exemplary embodiment will be described.

FIG. **2** is a block diagram to show the configuration of the image processing section **10** according to the exemplary embodiment of the invention.

The image processing section **10** includes a controller **11**, which may serve as a receiving section, and a printer engine control section **20**.

The configuration example shows one which receives image data in a PDL (page description language) format from an external personal computer, etc., (client PC **2**) and forms an image in the marking engine **30**.

Respective functional processing sections will be described with reference to FIG. **2**.

The controller **11** includes a PDL interpretation section **11**A, a drawing section **11**B, and a rendering section **11**C.

The PDL interpretation section **11**A interprets a command in the PDL (page description language) sent from the client PC **2**.

The drawing section **11**B converts a color signal (RGB) specified by the interpreted PDL into a color signal (YMCK) of the marking engine **30**. The drawing section **11**B converts the resolution of raster data of an image, etc., into engine resolution and converts image data of text/graphics into raster data having an engine resolution. To draw, an object tag of raster, text, or graphics is added for each pixel.

The rendering section **11**C renders image data into image data fitted to a printer engine.

The printer engine control section **20** includes an edge detection section **21**, a screen processing section **22**, and a pulse width modulation section **23**. The functional sections having the same configurations are provided in a one-to-one correspondence for the respective color signals (Y, M, C, and K).

The edge detection section **21** performs edge detection for each pixel by density difference determination using an edge detection window. The edge detection section **21** separates into an edge area and a non-edge area and adds edge determination tags, namely, an edge part tag to the edge area and a non-edge part tag to the non-edge area.

FIG. **3** is a schematic representation of an example of edge detection by the edge detection section **21**.

That is, FIG. **3**A shows a 3×3 pixel edge detection window. Densities of pairs of three pixels in surroundings of a pixel in question located at the center in FIG. **3**A are compared with each other (in longitudinal, lateral, slanting directions) as shown in FIG. **3**B to find differences SH, SV, SR, and SL (density difference determination). Then, these differences are compared with a predetermined edge threshold value. If any one of the differences is equal to or greater than the edge threshold value, the pixel in question is determined as an edge area; otherwise, the pixel in question is determined as a non-edge area.

The screen processing section **22** performs a screen process (binarization process) according to an area coverage modulation method. In the exemplary embodiment, gradation is represented by a halftone dot method.

FIG. **4** is a drawing to show an example of a unit cell of a threshold matrix (unit threshold matrix) used in the screen processing section **22**.

The screen processing section **22** includes a normal processing section **22**A for performing a screen process with a low number of lines per inch, and an edge processing section **22**B for performing a screen process with a high number of lines per inch. The screen processing section **22** also includes a memory **22**M, which may serve as a storage section for storing a threshold matrix used for the screen process, and a threshold conversion section **22**C for converting the stored threshold matrix.

The memory **22**M stores plural threshold matrices (non-edge area threshold matrices) to perform a screen process with (i) different numbers of lines per line and (ii) different screen angles, in response to objects. The non-edge area threshold matrix is set so as to perform a screen process with 300 lines per inch for text or a line, 200 lines per inch for an image, and 150 lines per inch for graphics, for example. In the exemplary embodiment, the non-edge area threshold matrix is stored in the memory **22**M in a state of a screen matrix obtained by expanding a unit cell of a threshold matrix shown

in FIG. **4**A according to a cyclic matrix method, etc. The example shown in FIG. **4**A is a 16×16 dot unit cell. The one unit cell forms one halftone dot, which grows in response to a density. If image information subjected to a screen process using the screen matrix obtained by expanding such a unit cell is drawn in 2400 dpi, the number of lines per inch becomes **150**.

The threshold conversion section **22**C generates a threshold matrix with a larger number of lines per inch (edge area threshold matrix) based on the non-edge area threshold matrix which correspond to each object and which is stored in the memory **22**M. The edge area threshold matrix is set so as to have the number of lines per inch, which is an integer multiple of the non-edge area threshold matrix based on which the edge area threshold matrix is generated. Such an edge area threshold matrix can be created by thinning out threshold values at predetermined intervals from the non-edge area threshold matrix. For example, if the threshold values of the 16×16 dot unit cell shown in FIG. **4**A are thinned out every other threshold value to form an 8×8 dot unit cell as shown in FIG. **4**B, the number of lines per inch becomes 300, double in 2400 dpi.

The screen angle of the edge area threshold matrix is set equal to the screen angle of the non-edge area threshold matrix. It is assumed that the non-edge area threshold matrix is stored in the memory **22**M as a screen matrix obtained by expanding a unit cell of a threshold matrix as in the exemplary embodiment. If the threshold values of the non-edge area threshold matrix are thinned out to generate the edge area threshold matrix, the non-edge area threshold matrix and the edge are threshold matrix become equal in the screen angle. If the non-edge area threshold matrix is stored in the memory **22**M in a state of a unit cell and the unit cell is expanded subsequently to perform a screen process, expansion is executed so that the non-edge area threshold matrix and the edge are threshold matrix become equal in the screen angle.

Based on the edge determination tag added by the edge detection section **21**, the screen processing section **22** performs a screen process in the normal processing section **22**A for the non-edge area and performs a screen process in the edge processing section **22**B for the edge area.

The normal processing section **22**A performs the screen process with a different number of lines per line (and/or at a different angle) for each object. That is, the normal processing section **22**A performs the screen process using the non-edge area threshold matrix corresponding to the object from among the non-edge area threshold matrices stored in the memory **22**M based on the object tag added by the drawing section **11**B of the controller **11**.

The edge processing section **22**B performs the screen process using the edge area threshold matrix, which is generated by the threshold conversion section **22**C based on the non-edge area threshold matrix corresponding to the object. Accordingly, for the edge area, the screen process is performed with a higher number of lines per inch than the non-edge area, and jaggies in the edge area are made inconspicuous.

The number of lines per inch of the screen using the edge area threshold matrix is set to be an integer multiple of the number of lines per inch of the screen using the non-edge area threshold matrix as mentioned above. The edge area threshold matrix and the non-edge area threshold matrix are made equal to each other in the screen angle. Accordingly, periodical density change caused by screen interference in the screen boundary portion therebetween can be suppressed. If density change occurs, it can be made inconspicuous. The reason will be described below.

FIG. **5** is a drawing to describe the screen angle effect in the screen process for the edge area. FIG. **6** is a drawing to describe periodicity of a screen boundary portion.

That is, FIG. **5**A conceptually shows an edge portion of image information. An area indicated by halftone dots on the left of FIG. **5**A is a drawing area at density 31% and the boundary portion with the blank (no dot) area on the right of FIG. **5**A is an edge. The squares at density 31% forming the edge are an edge area. One cell in FIG. **5**A is one dot at 600 dpi. FIGS. **5**B and **5**C show examples of drawing such image information at **2400** dpi using a screen having 300 lines per inch (one unit cell=8×8 dots) for the non-edge area and a screen having 600 lines per inch (one unit cell=4×4 dots) for the edge area. FIG. **5**B shows an example wherein both the non-edge area and the edge area are set to have the same screen angle (90 degrees). FIG. **5**C shows an example wherein the non-edge area and the edge area are set to have different screen angles, namely, the non-edge area is set to 67 degrees and the edge area is set to 90 degrees. As seen in FIGS. **5**B and **5**C, if the screen angles differ as shown in FIG. **5**C, parts where the halftone dots of the non-edge area and the halftone dots of the edge area are continuous (are in contact with each other) appear periodically as indicated by X in FIG. **5**C and is visually recognized as being lumpy and becomes unsightly. In contrast, if the screen angles are made equal to each other as in the example shown in FIG. **5**B, the halftone dots drawing the non-edge area and the halftone dots drawing the edge portion are aligned completely (uniformly) in the positional relationship. Therefore, periodical density change does not occur in the screen boundary portion and an image defect can be prevented.

FIG. **6** shows an example wherein the screen process is performed for the non-edge area with 212 lines per inch and for the edge area with 424 lines per inch (twice 212 lines per inch). In this example, the halftone dots of the edge area are continuous to the halftone dots of the non-edge area every other line as indicted by Y in FIG. **6**. That is, density periodicity occurs in the screen boundary portion. However, since the number of lines per inch of the edge area is an integer multiple of the number of lines per inch of the non-edge area (twice), the density period is not longer than the screen period of the non-edge area. Therefore, the defect is not conspicuous in visual recognition. That is, an image defect can be suppressed.

The pulse width modulation section **23** performs pulse width modulation for the image data subjected to the screen process by the screen processing section **22**, and supplies an image signal to the marking engine **30**.

Next, the whole operation of the image processing section **10** will be described.

FIG. **7** is a flowchart to show a flow of image processing executed by the client PC **2**, the image processing section **10**, and the marking engine **30**. Steps **102** to **109** are processes executed by the image processing section **10**. The reference numerals of the functional processing sections are shown in FIG. **2**.

First, the printer driver of the client PC **2** converts a command from application software into a PDL (printer description language) of a drawing command of a printer (step **101**).

The drawing command of the PDL is sent from the client PC **2** to the image formation apparatus **1**. In the image processing section **10** of the image formation apparatus **1**, the PDL interpretation section **11**A interprets the acquired PDL command (step **102**).

Then, the drawing section **11**B converts the color signal (RGB) specified by the interpreted PDL into a color signal (YMCK) of the marking engine **30** (step **103**). After the color

conversion, the drawing section **11**B and the rendering section **11**C form a raster image of engine resolution (step **104**). In drawing by the drawing section **11**B, corresponding object tags are added to image, text, and graphics (step **105**). The image data is sent to the printer engine control section **20** through an eight-bit multilevel interface (I/F), for example.

In the printer engine control section **20**, the edge detection section **21** detects an edge for each pixel and adds edge determination tags, that is, an edge part tag to the edge area and a non-edge part tag to the non-edge area (step **106**).

Then, the screen processing section **22** executes a screen process for the edge area and the non-edge area with different numbers of lines per inch using the threshold matrix (step **107**).

That is, according to the edge determination tags added by the edge detection section **21**, the normal processing section **22**A performs a screen process for the non-edge area and the edge processing section **22**B performs a screen process with a higher number of lines per inch for the edge area. This topic is described later in detail.

Then, the image data for each object of the non-edge area and the image data of the edge area separately subjected to the screen process are merged and the resultant image data is input to the pulse width modulation section **23**, which then modulates the image data subjected to the screen process by the screen processing section **22** into a pulse signal (step **108**).

The image data obtained by executing the pulse modulation is output to the marking engine **30** (step **109**).

When the marking engine **30** acquires the image data, it forms a color image on record paper and prints out the image by the components as shown in FIG. **1** (step S**110**).

FIG. **8** is an operation flow of the screen processing section **22**.

After receiving image data (step **201**), the screen processing section **22** classifies the image data (pixels) into an edge area and a non-edge area based on the edge determination tags for the respective pixels (step **202**).

For the non-edge area, the normal processing section **22**A reads the corresponding non-edge area threshold matrix from the memory **22**M based on the object tag (step **203**) and performs the screen process with a different number of lines per line (and/or at a different angle) for each object (step **204**).

On the other hand, for the edge area, the corresponding non-edge area threshold matrix is read from the memory **22**M based on the object tag, and is converted into an edge area threshold matrix by the threshold conversion section **22**C (step **205**). Using the edge area threshold matrix, the screen process is performed with a different higher number of lines per line (and/or at a different angle) for each object (step **206**).

It is to be understood that the invention is not limited to the specific embodiment thereof and various modifications and changes can be made appropriately.

For example, the exemplary embodiment described above is an example of applying the invention to the color image formation apparatus, but the invention may be applied to a monochrome image formation apparatus.

What is claimed is:

1. An image processing apparatus comprising:

a receiving section that receives image information;

an edge detection section that detects an edge area from the image information received by the receiving section for each pixel by density difference determination, separates the image information into the edge area and a non-edge area, and adds edge determination tags to at least one of the edge area and the non-edge area; and

a screen processing section that performs a screen process, which is based on area coverage modulation, for the image information on a basis of the detection result by the edge detection section, wherein:

the screen processing section performs a screen process for the edge area detected by the edge detection section with (i) a screen angle, which is equal to that of a screen process performed for the non-edge area other than the edge area, and (ii) a number of lines per inch, which is an integer multiple of that of the screen process performed for the non-edge area.

2. The apparatus according to claim **1**, wherein the screen processing section comprises:

a storage section that stores a non-edge area threshold matrix for use in the screen process for the non-edge area; and

a matrix conversion section that generates, based on the non-edge area threshold matrix, an edge area threshold matrix for use in the screen process for the edge area.

3. An image processing apparatus comprising:

a receiving section that receives image information;

an edge detection section that detects an edge area of the image information received by the receiving section for each pixel by density difference determination, separates the image information into the edge area and a non-edge area, and adds edge determination tags to at least one of the edge area and the non-edge area; and

a screen processing section that performs a screen process, which is based on area coverage modulation, for the image information on a basis of the detection result by the edge detection section, wherein:

the screen processing section comprises:

a storage section that stores a non-edge area threshold matrix for use in a screen process for the non-edge area other than the edge area detected by the edge detection section; and

a matrix conversion section that generates, based on the non-edge area threshold matrix, an edge area threshold matrix for use in a screen process for the edge area.

4. The apparatus according to claim **3**, wherein the screen processing section uses the edge area threshold matrix to perform the screen process for the edge area with (i) a screen angle, which is equal to that of the screen process performed for the non-edge area using the non-edge area threshold matrix, and (ii) a number of lines per inch, which is an integer multiple of that of the screen process for the non-edge area.

5. The apparatus according to claim **4**, wherein the matrix conversion section thins out threshold values at predetermined intervals from the non-edge area threshold matrix to generate the edge area threshold matrix.

6. An image processing method comprising:

receiving image information;

detecting an edge area from the received image information for each pixel by density difference determination;

separating the image information into the edge area and a non-edge area;

adding edge determination tags to at least one of the edge area and the non-edge area; and

performing a screen process, which is based on area coverage modulation, for the image information on a basis of the detection result, wherein:

the performing comprises performing a screen process for the detected edge area with (i) a screen angle, which is equal to that of a screen process performed for the non-edge area other than the edge area, and (ii) a number of lines per inch, which is an integer multiple of that of the screen process performed for the non-edge area,

wherein at least one of the steps is executed using a processor.

7. An image processing method comprising:
receiving image information;
detecting an edge area of the received image information for each pixel by density difference determination;
separating the image information into the edge area and a non-edge area;
adding edge determination tags to at least one of the edge area and the non-edge area;
performing a screen process for the non-edge area other than the edge area, using a predetermined non-edge area threshold matrix;
generating, based on the non-edge area threshold matrix, an edge area threshold matrix; and
performing a screen process for the edge area using the generated edge area threshold matrix,
wherein at least one of the steps is executed using a processor.

8. The method according to claim 7, wherein the screen process performed for the edge area using the edge area threshold matrix is performed with (i) a screen angle, which is equal to that of the screen process performed for the non-edge area using the non-edge area threshold matrix, and (ii) a number of lines per inch, which is an integer multiple of that of the screen process performed for the non-edge area.

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